

WHAT IS CLAIMED IS:

1. A balanced amplifier comprising:

a pair of voltage-to-current converters each

including

5 a first input terminal,

a second input terminal,

a first output terminal and

a second output terminal,

each of the voltage-to-current converters

10 converting differential input voltages applied to the first input terminals of the converters into output currents output from both of the first output terminal and the second output terminal of each of the converters;

15 wherein the second input terminals and the second output terminals of the converters are connected in common to cancel common-mode components and extract differential components.

2. The balanced amplifier according to claim 1,

20 wherein each of the voltage-to-current converters comprises a common source amplifier.

3. The balanced amplifier according to claim 1,

which further includes a first impedance connected between the first input terminal and the first output terminal of one of the converters and a second impedance connected between the first input terminal and the first output terminal of the other of the

converters.

4. The balanced amplifier according to claim 3,  
which includes a first input side impedance connected  
to the first input terminal of one of the converters  
5 and a second input side impedance connected to the  
first input terminal of the other of the converters.

5. A balanced amplifier comprising:  
a first voltage-to-current converter and a second  
voltage-to-current converter, each of the first  
10 voltage-to-current converter and the second voltage-to-  
current converter including

a first input terminal,  
a second input terminal,  
a first current source which outputs a first  
15 current,  
a second current source which outputs a second  
current,  
a first output terminal outputting a third current  
and  
20 a second output terminal outputting a fourth  
current,

wherein the third current is obtained by  
subtracting a sum current from the first current,  
the sum current corresponding to sum of currents  
25 corresponding to voltages applied to the first input  
terminal and the second input terminal respectively,  
and the fourth current being obtained by subtracting

the sum current from the second current, and

wherein the second input terminal and second output terminal of the first voltage-to-current converter and the second input terminal and second output terminal of the second voltage-to-current converter is connected in common, a differential input signal is input to the first input terminals of the first voltage-to-current converter and the second voltage-current converter, and a differential output signal is output from the first output terminal of the first voltage-to-current converter and the second voltage-current converter.

6. The balanced amplifier according to claim 5, which includes a first impedance element connected in parallel to the first voltage-to-current converter between the first input terminal and the first output terminal of the first voltage-to-current converter, and a second impedance element connected in parallel to the second voltage-to-current converter between the first input terminal and the first output terminal of the second voltage-to-current converter.

7. The balanced amplifier according to claim 6, which includes a plurality of impedance elements each supplied with the differential input signal, wherein at least one of the plurality of impedance elements is connected to the first input terminal of each of the converters.

8. The balanced amplifier according to claim 6,  
which includes a plurality of single input/single  
output voltage-to-current converters to which the  
differential input signal is supplied, and wherein at  
5 least one of the plurality of the single input/single  
output voltage-to-current converters is connected to  
the first input terminal of each of the converters.

9. A filter comprising the balanced amplifier  
according to claim 6.

10. The balanced amplifier according to claim 5,  
which further comprises a third voltage-to-current  
converter having a configuration equal to that of the  
first voltage-to-current converter and the second  
voltage-to-current converter, and wherein a first input  
15 terminal and an output terminal of the third voltage-  
to-current converter are connected to the first input  
terminal of the first voltage-to-current converter, and  
a second input terminal and a second output terminal of  
the third voltage-to-current converter are connected to  
the first input terminal of the second voltage-to-  
current converter.

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25 11. The balanced amplifier according to claim 10,  
wherein each of the first voltage-to-current converter,  
the second voltage-to-current converter, and the third  
voltage-to-current converter comprise a third input  
terminal and a fourth input terminal, and the first  
current source and the second current source supply

a sum current corresponding to sum of the currents corresponding to voltages applied to the third input terminal and the fourth input terminal to the first output terminal and the second output terminal of each 5 of the first voltage-to-current converter and the second voltage-to-current converter.

12. The balanced amplifier according to claim 10, wherein each of the first voltage-to-current converter, the second voltage-to-current converter and the second 10 voltage-to-current converter includes a first power line and a second power line, and two transistors connected in series between the first power line and the second power line.

13. A filter comprising the balanced amplifier 15 according to claim 10.

14. The balanced amplifier according to claim 5, wherein each of the first voltage-to-current converter and the second voltage-to-current converter comprise a third input terminal and a fourth input terminal, and 20 the first current source and the second current source supply a sum current corresponding to sum of the currents corresponding to voltages applied to the third input terminal and the fourth input terminal to the first output terminal and the second output terminal of each 25 of the first voltage-to-current converter and the second voltage-to-current converter.

15. The balanced amplifier according to claim 5,

wherein each of the first voltage-to-current converter  
and the second voltage-to-current converter includes  
a first power line and a second power line, and two  
transistors connected in series between the first power  
line and the second power line.

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16. A balanced amplifier comprising:

a first voltage-to-current converter and a second  
voltage-to-current converter, each of the first  
voltage-to-current converter and the second voltage-to-  
current converter including:

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a first input terminal,  
a second input terminal,  
a first output terminal and  
a second output terminal, and

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each of the first voltage-to-current converter  
and the second voltage-to-current converter supplying a  
current corresponding to sum of currents corresponding  
to voltages applied to the first input terminal and  
the second input terminal respectively to the first  
output terminal and the second output terminal so that  
20 a polarity of an output signal from the first output  
terminal is reversed with respect to a polarity of  
an input signal to the first input terminal, and  
a polarity of an output signal from the second output  
terminal is reversed with respect to a polarity of  
25 an input signal to the second input terminal,

an input signal to the second input terminal,

wherein the second input terminals and second

output terminals of the converters is connected in common, a differential input signal is input to the first input terminals of the converters, and a differential output signal is output from the first 5 output terminals of the converters.

17. The balanced amplifier according to claim 16, wherein each of the first voltage-to-current converter and the second voltage-to-current converter further includes a third input terminal and a fourth input 10 terminal, and supplies to the first output terminal and the second output terminal a sum current corresponding to sum of currents corresponding to input voltages applied to the third input terminal and the fourth input terminal so that polarities of output signals 15 from the first output terminal and the second output terminal coincide with polarities of input signals to the third input terminal and the fourth input terminal.

18. The balanced amplifier according to claim 16, wherein each of the first voltage-to-current converter, 20 the second voltage-to-current converter and the third voltage-to-current converter further includes a third input terminal and a fourth input terminal, and supplies to the first output terminal and the second output terminal a sum current corresponding to sum of currents corresponding to input voltages applied to the third input terminal and the fourth input terminal so 25 that polarities of output signals from the first output

terminal and the second output terminal coincide with polarities of input signals to the third input terminal and the fourth input terminal.

19. A voltage-to-current converter comprising:

5           a first input terminal,  
              a second input terminal,  
              a first output terminal, and  
              a second output terminal;  
              an adder which adds voltage signals supplied to  
10          the first input terminal and the second input terminal  
respectively;

              a first inverting amplifier which reverses and  
              amplifies an output of the adder;

15          a second inverting amplifier which reverses and  
              amplifies the output of the adder;

              a third inverting amplifier which reverses and  
              amplifies an output of the first inverting amplifier  
              and outputs a first reversed and amplified signal to  
              the first output terminal as a first current signal;

20          a fourth inverting amplifier which reverses and  
              amplifies an output of the second inverting amplifier  
              and outputs a second reversed and amplified signal to  
              the second output terminal as a second current signal;

25          a first capacitor connected between an input  
              terminal and an output terminal of the third inverting  
              amplifier; and

              a second capacitor connected between an input

terminal and an output terminal of the fourth inverting amplifier.

20. A voltage-to-current converter according to claim 19, wherein each of the adder, the first inverting amplifier, the second inverting amplifier, the third inverting amplifier and the fourth inverting amplifier includes two transistors connected in series between a first power source and a second power source.

21. A balanced amplifier comprising two voltage-to-current converters each according to claim 19, wherein the second input terminals and the second output terminals of the converters being connected in common, a differential input signal is input from the first input terminals of the converters, and a differential output signal is output from the first output terminals of the converters.

22. A balanced amplifier comprising:

a first and a second converters, each being a voltage-to-current converter and each including

20 a first and a second input terminals,

a first current source supplying a first current,

a second current source supplying a second current,

25 a first subtractor generating a third current by subtracting a sum current representing sum of currents corresponding to voltages applied to the first and second input terminals, from the first current,

a second subtractor generating a forth current by subtracting the sum current from the second current,

a first output terminal outputting the third current, and

5 a second output terminal outputting the fourth current,

wherein both of the second input terminals of the first and the second converters and both of the second output terminals of the first and second converters are  
10 connected in common, and

15 a differential input signal is applied to the first input terminals of the first and the second converter, thereby obtaining a differential output signal on the first output terminals of the first and the second converters.